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Analysis of Groundwater Quality Improvement Using Rainwater Harvesting: A Case Study of Jamia Millia Islamia

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ABSTRACT : *The availability of groundwater neither unlimited nor protected deterioration, in most of the instances the extraction of excessive qualities of ground water has resulted in drying up of wells, damaged ecosystem, land subsidence, saltwater intrusion and depletion of resources. the rate of depletion of ground water level and determination of ground water quality is concern in major cities and towns of countries. It is now recognized that the quality of ground water is as important as its quantity. this paper is an attempt to analyze the impact of rain water harvesting on ground water quality. the area of study is the jamia millia Islamia university new delhi india campus where rain water harvesting structure is installed. therefore the present paper analyses and interprets ground water quality using rainwater harvesting technique. So we can say that the rainwater recharges and improves the quality of ground water which is also depends upon the amount of rain water recharged and the environment of rainwater collection and recharging.*

Keywords: *Intrusion, Deterioration, Depletion, Aquifers*

I. INTRODUCTION

The introduction of the paper should explain the nature of the problem, previous work, purpose,

Water is an essential and vital component for our life support system. In tropical regions ground water plays an important role with context to fluctuating and increasing contamination of surface water resources. Ground water has unique features which render it particularly suitable for public water supply. It has excellent natural quality, usually free from pathogens, color and turbidity and can be consumed directly without treatment. Ground water is widely distributed and can be frequently developed incrementally at points near the wafer demand, thus avoiding the need for large water storage, treatment and distribution system. Unfortunately, the availability of ground water is not unlimited nor it is protected from deterioration. In most of the instances, the extraction of excessive quantities of ground water has resulted in drying up of wells, damaged ecosystems, land subsidence, salt water intrusion and depletion of the resources. Ground water quality is being increasingly threatened by agriculture, urban & industrial wastes, which leach or are injected into underlying aquifers. It has been established that once pollution has entered the subsurface environment, it may remain concealed for many years, becoming dispersed over wide areas of ground water aquifer and rendering ground water supplies unsuitable for consumption and other uses. The rate of depletion of ground water levels and deterioration of ground water quality is of concern in major cities and towns of the country. Being a National Capital Territory, Delhi is facing multifaceted problems regarding water availability, and quality. The population growth and rapid urbanization in and around Delhi has led to immense pressure on basic emanate such as water supply. Deepak Khare et al. (2004) have assessed the impact of RWH on groundwater quality at Indore and Dewas in India using the data from existing tube wells. The roof top rainwater was put through sand filter leading to a reduction in the concentration of pollutants in groundwater. Sharma and Jain (1997) conducted an experiment in Nagpur city where 80,000 liters of water, Collected from the roof top of 100 m2 area was recharged. The rise in water level up to 1 m was recorded in the recharge well and adjoining dug wells. The quality of groundwater has also improved as nitrate concentrations got diluted considerably to the desirable limit. Vijaya Kumar (2005) has evaluated the ground water potential by groundwater estimation committee (GEC 1997) norms. Venkateswara Rao (1996) has reviewed the importance of artificial recharge of rainfall for Hyderabad city water supply. A simulation model has been developed by Srivastava (2001) to design a system for determining catchment /command area ratio, size of tank, desirable command area of a single tank and the feasibility/economics of lining a tank. Fayez and Shareef (2009) carried out the research to evaluate the potential for potable water savings by using rainwater in residential sectors of the 12 Jordanian governorates and provided suggestions and recommendations regarding the improvement of both quality and quantity of harvested rainwater. Sazaklia et al (2007) analyzed the quality of harvested rainwater, which is used for domestic and drinking purposes in the northern area of Kefalonia Island in Greece. The influential factors were assessed through a 3-yearsurveillance. Principal component analysis revealed that microbiological parameters were affected mainly by the cleanness level of catchment areas, while chemical parameters were influenced by the sea proximity and human activities. This paper is an attempt to analyzing the impact of rainwater harvesting on ground water quality of the Jamia Millia Islmia campus which is major challenging issue where the rainwater harvesting structures were installed. The Jamia Millia Islamia is spread over vast area

of 205 acres of land at Jamia Nagar, New Delhi. It has 15% covered area and the remaining area is open space. Depending upon the area of sub-campuses, the campus of the Jamia Millia Islamia is divided into Ten Zones for the installation of rainwater harvesting structures. The rainfall in Delhi area is confined to the month July, August and September (i.e. 90%) and rest of the 10% in the other nine months namely(February, March, April, May, October and November) goes dry. According to Meteorological Department the average rainfall is about 611.0 mm per year with the humidity varying from 17% - 89% and temperature variation from 3º C to 48º C. The evaporation recorded as 1.7 m. The Specific Yield varies in the study area from 16% to 20%.

II. OBJECTIVES

The rainwater harvesting structures were installed at Engineering faculty, Gaddha Colony, department of Fine Arts, University Polytechnic and Administrative Block and the scope of the project is impact of rainwater harvesting on groundwater quality, the steps are to be followed:

1. The fallowing groundwater quality analysis data at pre-installation period of the rainwater harvesting structures at the JMI
2. To collect the groundwater samples in the Post-Monsoon period covering the entire JMI campus area in order to analyses the impact of rainwater harvesting on groundwater quality.
3. Collection of groundwater samples after few months lo know the changes in the groundwater quality since the post-monsoon times.
4. Comparative Study of quality of all the three-groundwater quality test results in order to ascertain the overall impact of Rainwater Harvesting on groundwater quality of the campus area.

III. METHODOLOGY

To achieve the main objectives of the study following methodology have been adopted

1. Groundwater Quality Test Results of February 2011 are arranged and analyzed.
2. Groundwater Samples were collected in the month of November, 2011 (Post-Monsoon period) and analyzed.
3. Groundwater Samples were collected in the month of April 2012, in order to know the changes in the groundwater quality since the rainwater recharge.
4. All the three groundwater quality test results of the JMI was compiled and comparative study was done to reveal the overall impact of rainwater harvesting on groundwater quality of the JMI campus.
5. Analysis of rainwater sample and groundwater sample of the JMI Campus in order to check the impact of rainwater harvesting.
6. Study of the impact of rainwater harvesting on groundwater quality potential of the JMI

IV. ADVANTAGES OF ARTIFICIAL RECHARGE

Man plans most artificial recharge projects for specific purpose of saving or storing fresh water for subsequent use. Among these projects some may serve the dual purpose of eliminating objectionable amounts of water at the land surfaces and, at the same time putting this water into reserve for eventual extraction.

V. HYDRAULIC EFFECTS DUE TO ARTIFICIAL RECHARGE

Two hydraulic effects are generated by artificial recharge as a result of the head, which is applied in the recharge area and the mass of the water, which is introduced into the aquifer through the recharge area, the piezometric effect and the volumetric effect. The piezometric effect results in a rise in the piezometric surface in the unconfined aquifers and /or a rise of the artesian pressure in the confined aquifers. The piezometric effect is related to three main factors. First, it is related to factors which create a damping effect is related to shape of the piezometric surface to the geological and hydraulic boundaries of the aquifer and to the type of location of the recharging device secondly, it is related to quotient T/C (T=transmissivity coefficient; C=replenishment coefficient which is equivalent of storage coefficient). Thirdly, it is related to the artificial recharge yield and the duration of operation. Other factors such as capillary forces water temperature and presence of air bubbles in the aquifers also have in impact on the piezomtric effect. The volumetric effect is related to specific yield, replenishment coefficient, the transmissivity coefficient and the boundary coefficient model studies that were checked through filled experiments have demonstrated that the bulk of the recharge water move according to the two systems of flow. One results in a spreading out effect, with a speed related to the recharge flow, the other in the sliding effect, with a speed related to ground water flow.

VI. IMPACT ASSESSMENT OF RAINWATER HARVESTING AT JAMIA MILLIA ISLAMIA CAMPUS

A) Rainwater Harvesting and Groundwater Quality

The rainwater harvesting is done primarily for the qualitative improvement, irrespective of its methods, whether collecting rainwater in ponds or reservoirs for future use or by recharging the rainwater to the groundwater aquifers through bore hole drilled for the purpose. Apart from the qualitative improvement of groundwater as a result of dilution of certain chemical constituents and dissolved solids. This qualitative improvement of groundwater is utmost importance because where there is saline groundwater or the chemical constituents are more than the desirable or maximum permissible limits, the rainwater recharging the aquifers dilutes it to make it useful for drinking and other proposes, very often. The urbanization, agricultural development, and discharges of municipal and industrial residues into the water resources significantly alter its characteristics. The prevailing climatic conditions, topography, geological formations and use and abuse of this vital resource have significant affect on the characteristic of the water, because of which its quality varies with locations. The term water quality criteria may be defined as the "Scientific data evaluated to derive recommendations for characteristics of water for specific use". The quality analysis conducted on

the groundwater samples collected during the month of February 2011, in the post-monsoon period in the month of November 2011 and in April 2012 reveals this truth of qualitative improvement of groundwater through rainwater recharge to the aquifers,

B) Sampling and Analyses of Groundwater

The ground water quality monitoring studies were undertaken during the months of February 2011, November 2011 and April 2012. As the water systems are heterogeneous to varying degrees in space and time, the water samples were collected at from Tube wells and injection wells located at Engineering faculty, Gaddha Colony, Department of Fine Arts, University Polytechnic and Administrative Block, covering the entire campus area. All the ground water samples were preserved in the field itself and transported to the laboratory for water quality testing.

C) Qualitative Impact of Rainwater Harvesting, at JMI

The groundwater quality of Jamia Millia Islamia has been tested in the month of February 2011 by collecting 10 groundwater samples from the existing tube wells. The following table-1 shows the parameters considered for the test and their results:

TABLE-1: GROUNDWATER QUALITY ANALYSIS (FEBRUARY, 2011)

S. No.	Parameters	Values
1.	pH	7.0 – 8.1
2.	Total Hardness	240 – 778 mg/l
3.	Nitrate	4.1 – 145.6 mg/l
4.	Chloride	96 – 828 mg/l
5.	Sulphate	70 – 270 mg/l
6.	Flouride	0.2 – 1.4 mg/l
7.	TDS	360 – 1337 mg/l

The concentrations of various parameters at the entire Jamia campus are shown in the above table 1Later on, groundwater samples were taken twice during the months of November 2011 (13 samples) and April 2012 (13 samples) from the existing tube wells and injection wells at the campus for the comparative analysis of the groundwater quality before and after rainwater recharging

The comparative analysis of the groundwater quality before and after rainwater recharging.

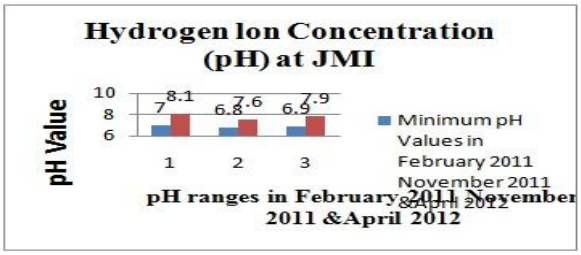

Figure: 1 Comparative Hydrogen Ion concentrations (pH)

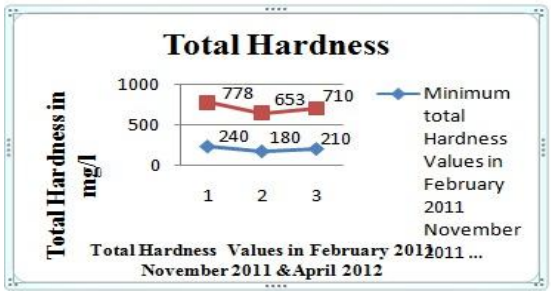

Figure: 2 Comparative Total Hardness

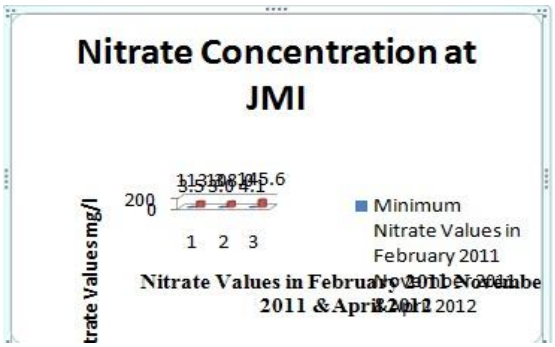

Figure: 3 Comparative Nitrate Concentrations

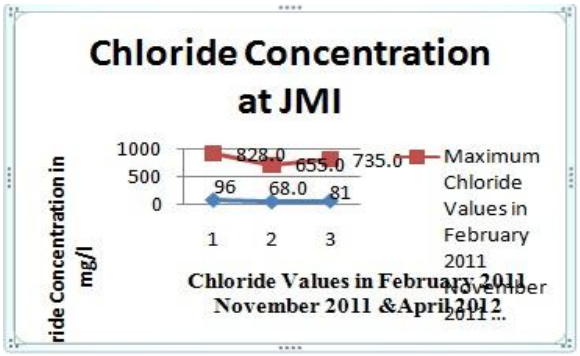

Figure: 4 Comparative chloride Concentration

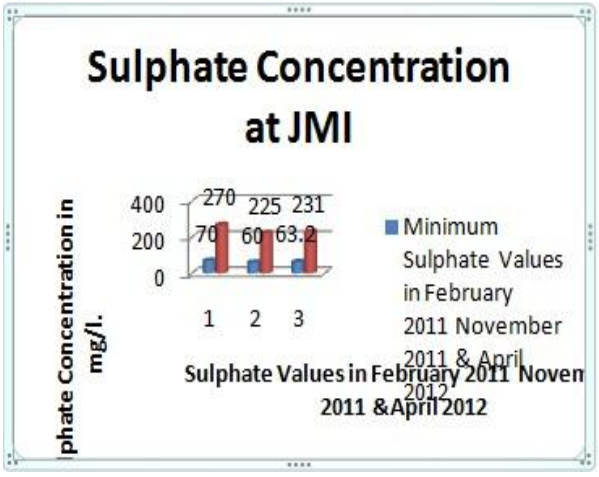

Figure: 5 Comparative Sulphate Concentration

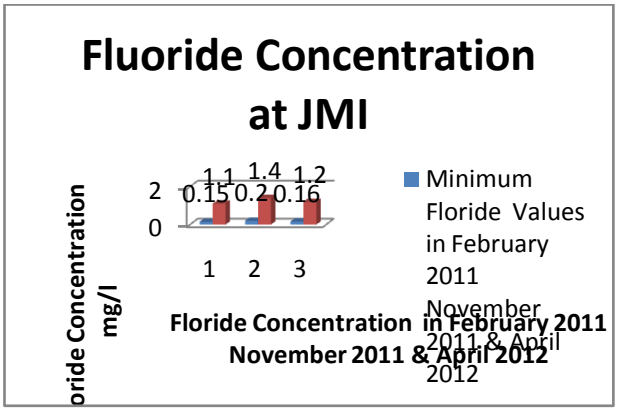

Figure: 6 Comparative Fluoride Concentration

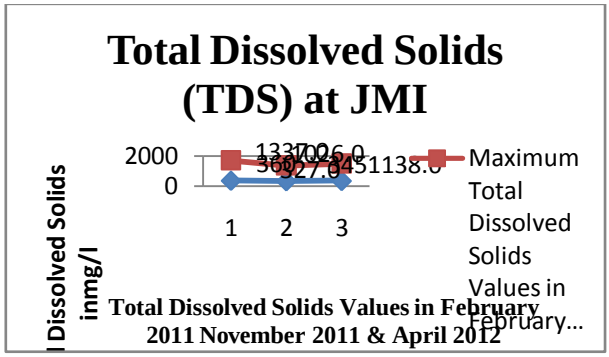

Figure: 7 Comparative Total Dissolved solids (TDS) Concentration

From the account of analysis of groundwater quality it is evident that the significant reduction in concentration of different chemical constituents is the result of dilution of these substances by the rainwater, which is pure and has the pH 5.2. Again, these chemical constituents attain slightly higher concentration level due to the withdrawal of groundwater and the dispersal of the localized recharged water to the downstream areas

D) Rainfall during the Year 2011 and Impact on Groundwater Quality

The south-west monsoon of 2011 was marked by near-normal rainfall over the country distributed equitably over both space and time. In Delhi, the rainfall recorded during 2011 was 748 mm, higher than the average annual rainfall of about 611.0 mm. This 137.0 mm increase in rainfall resulted in the greater than the normal recharge, The Rainwater Potential of the campus area, i.e., amount of rainwater recharge to the aquifer during the year 2011 was 49 % more than the average potential. Hence, it had a bearing on the groundwater quality. As a result, the pH and other chemical constituent have shown the substantial decrease in their concentration by the dilution through the rainwater and after a few months (in April 2012), the slight increase was recorded in the concentration as depicted in the comparative groundwater quality test data in the table-2.

Table-2 Comparative Groundwater Quality Analysis

S. No.	Constituents	Indian Standard	Range of water quality parameter tested			
		Desirable limits	Maximum Permissible limits	February 2011	November 2011	April 2012
1	pH	6.5.8.5	6.5.-9.5	7.0-8.1	6.8-7.6	6.9-7.9
2	Total Hardness (mg/L)	300	600	240-778	180-653	210-710
3	Nitrate (NO_3) (mg/L)	45	100	4.1-145.6	3-108	3.5-113.3
4	Chloride (mg/L)	250	1000	96-228	68-655	81.735
5	Sulphate (SO_4) (mg/l)	200	400	70-270	60-225	63.2-231
6	Fluoride (F) (mg/L)	1.0	1.5	0.2-1.4	0.15-1.1	0.16-1.2
7	Total Dissolved Solid (mg/L)	500	2000	360-1337	327-1026	342-1138

The groundwater quality test result for each of the samples collected during the months of February 2011, November 2011 and April 2012

E) Salinity Scenario

The Jamia Millia Islamia campus has both the fresh and saline groundwater extractions. The saline water availability is more than fresh. The salinity increases with depth like in Mujeeb bagh area. The rainwater recharged to the aquifer dilutes the salt concentration in ground water.

VII. CONCLUSION

The rainwater harvesting structures were installed at various at the JMI at the 20 meters depth. The other dimensions of ponds and injection wells are varying as per the designs and cross-sections enclosed. It is said while going for the installation of rainwater harvesting structures at JMI that the declining trend of the groundwater level will occur if the rainwater harvesting system will not be adopted. There was the mention of the improvement in groundwater quality of the area. this paper is an effort to analysis the impact of rainwater harvesting at the JMI, qualitatively. The ground water samples collected analyzed in the months of February 2011, November 2011 and April 2012. These data were analyzed and compared to know the analyses reveals a very interesting figure as for as the ground water quality improvement is concerned and approves the claim of quality improvement.

Therefore, in the light of the present work, analysis and interpretations, it can be concluded that the rainwater recharge improves the quality of groundwater and its quality depends upon the amount of rainwater recharged and the environment of rainwater collection and recharging

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